# APPLICATION OF SPB RISK/HAZARD RATINGS AND DETERMINATION OF BASAL AREA MEASUREMENTS ON THE KISATCHIE NATIONAL FOREST

A Pilot Project

## ABSTRACT

Results show that of the seven SPB risk/hazard systems evaluated, one group of two measured the same, another group of two measured the same, and one was different from all other systems. These differences were compared at the 5 percent level of probability.

Basal area, a component of several risk/hazard systems, was estimated from U.S. Forest Service compartment prescription tally sheets, aerial photographs, and a 10 percent stand cruise. These were compared and included in stand risk/hazard rating procedures. No significant differences due to basal area measurement procedures were noted at the 5 percent level of probability.

## INTRODUCTION

One of the goals of National Forest Management is to provide a stable supply of wood products (sustained yield concept). Continuing southern pine beetle epidemics disrupt timber management and the even flow of forest products from National Forest lands. Efforts are being made in the site/stand research area to prevent some of these losses by identifying site/stand conditions which contribute to the SPB problem.

Pest managers now recommend that foresters use silvicultural means to reduce SPB outbreaks. (Coster, 1977). Hazard ratings can be used to help the forester achieve this goal by setting priorities for stand treatments. Stands could receive remedial treatment on a priority basis, which ultimately would reduce SPB losses.

## OBJECTIVES

The objectives of this evaluation were:

1. To determine how SPB risk rating measured the same forest stands.
2. To determine if there were differences in basal area estimates between compartment prescription tally sheets, aerial photos, and a 10 percent stand cruise.
3. To determine how different basal area measurement procedures might effect risk rating system measurement.

## METHODS

### Hazard Rating

Forty-three stands of timber located on the Kisatchie District, Kisatchie

National Forest, were selected to be used in the project. Stands selected were classed as pine stands. These stands were either in the process of being reviewed for silvicultural action or had been reviewed within the past year (1978).

Forty-three stands were hazard rated for susceptibility to southern pine beetle attack. A total of twenty treatments consisting of 6 hazard rating systems and various basal area measurement procedures were evaluated. These were:

1. G. Mason System (intuitive model presented at site/stand work shop, ESPBRAP, DeGray State Park, Ark.)
2. Porterfield System
3. Kushmal System
4. Ku System (prescription BA)
5. Ku System (photo method #1, see table 1)
6. Ku System (photo method #4, see table 1)
7. Ku System (photo method #5, see table 1)
8. Lorio System
9. Smith System (intuitive, variables weight =)
10. Smith System (intuitive, variable =, basal area from photo method #1)
11. Smith System (intuitive variable =, basal area from photo method #4)
12. Smith System (intuitive variable =, basal area from photo photo method #5)
13. Smith System (site index higher, prescription basal area)
14. Smith System (site index higher, photo method #1)
15. Smith System (site index higher, photo method #4)
16. Smith System (site index higher, photo method #5)
17. Smith System (stand age higher, prescription basal area)
18. Smith System (stand age higher, photo method #1)
19. Smith System (stand age higher, photo method #4)
20. Smith System (stand age higher, photo method #5)

Table 1. Formulas for determining basal areas from photos used in the project.

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Model #1

Pine basal area = - 18.693 + .4647 x crown closure (%)
+ .7268 x % actual pine stocking

Model #2

Pine basal area = - 3.9793 + .3792 x crown closure (%)
+ .6769 % estimated (photo) pine stocking

Model #3

Pine basal area = 66.03542 - .73759 x crown closure (%)
- .29308 % estimated (photo) pine stocking
+ .01535 x (crown closure % x pine stocking)

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Note: These three regression equations provided the same results when applied as treatments to the hazard rating systems. No differences were found at the 5 percent significance level between these treatments as they apply to these systems: 1) Ku and 2) Smith. $R^2$ values for all three formulas are approximately the same and results of equal quality can be expected by using any of the three formulas listed.

Six of these treatments provide the variables which compose the basic risk/hazard systems. The rest of the treatments differ from the six basic systems in that seven different methods of taking basal area were used (table 2). The six basic treatments (by author), and their variables are as follows:

1. Mason, G.- percent pine stocking, basal area, crown closure, DBH, and height (intuitive system, not validated). (Mason, 1979)
2. Porterfield - total pine cubic foot volume, percent pine basal area, slope percent, average bark thickness and last 10 years radial growth. (Porterfield and Rowell, 1978)
3. Kushmal - pine basal area, and radial growth. (Kushmal etal, 1977)
4. Ku - basal area (total, basal area (hardwood), average bark thickness, age, and last 10 years of radial growth. (Kurtal, 1979)
5. Smith - basal area, site index and stand age. Also intuitive, not validated. (unpublished)
6. Lorio - forest type, stand condition class, method of cut, operability and site index.

The systems designed by Kushmal, Ku, and Porterfield were adapted to provide results in the high risk/hazard = 1, medium risk/hazard = 2, and low risk/hazard = 3 format. This adjustment from published procedures was necessary for statistical analysis. Kushmal's system used only attack or resistance to describe results. This was modified to show attack as high risk/hazard (1) and resistance as low (3) risk/hazard. Analysis of variance (randomized block design) was run on all systems with Tukey's multiple range test used to group the treatments.

Table 2. Basal area sources used in hazard rating

| Basal area type | Source |
|---|---|
| 1. Pine basal area | Prescription (average of all points (pine only) |
| 2. Pine and hardwood basal area | Photo interpretation, method 1* |
| 3. Pine and hardwood basal area | Photo interpretation, method 4 |
| 4. Pine and hardwood basal area | Photo interpretation, method 5 |
| 5. Pine basal area | Photo interpretation, method 1 |
| 6. Pine basal area | Photo interpretation, method 4 |
| 7. Pine and hardwood basal area | Prescription (average of all points, pine and hardwood) |

* Regression formulas for photo interpretation methods 1, 4, and 5 are found on page 6. These formulas were derived using a basal area table technique described by M. Mathews 1978.

## Basal Areas

Basal areas, both pine and hardwood, were taken from the prescriptionist's tally sheet. Highest basal area, lowest basal area, and average basal area were taken for use as treatment groups. Photo basal area was attempted using factors under study at Stephen F. Austin State University. (Matthews, 1978). These factors were percent pine stocking and crown closure. Three regression equations were formed based on estimates of pine stocking, crown closure, and actual basal area figures from photos compared to plot results from the same 50 points in the field. (Table 2). These equations were used to calculate basal area from the photos. The same technician did all photo interpreting since the regression equations were determined from that technician's work only. This was done to minimize errors. Actual cruise data were taken on 10 stands. A 10 percent prism plot cruise was done to ascertain stand basal area. The purpose of this cruise was to determine if there were differences between what was actually in the stands (10 percent cruise) vs photo and prescription estimates of these figures. Once it was determined that the photos and cruise tally sheets were accurate (vs 10% cruise), prescriptionist's tally sheet measurements on 43 stands were compared to photo basal area to determine if significant differences existed. Statistical analysis of the basal area treatment was accomplished using the ANOVA (randomized block) with Tukey's multiple range test used to group like treatments. Basal area data taken from each source in the basal area study, was also used in the risk/hazard rating study.

# RESULTS

## Hazard Rating

Six basic hazard rating systems were analyzed to determine if they measured risk/hazard the same. Rating systems designed by Porterfield, Kushmal, and Mason seemed to measure SPB hazard the same and were different from all other ratings at the 5 percent level of significance (table 3 and pages 3 and 4). Lorio and Smith systems measured differently from all others at the 5 percent level of significance. Ku's method measured differently from all other systems at the 5 percent level of predictability. Ku's system (all variables present) is different in Louisiana from all other systems at the 5 percent level of probability.

These results should not be interpreted in a manner which would indicate one of the risk/hazard systems is better than the other. This project was designed to group risk/hazard systems which measured SPB hazard the same.

Any interpretation other than the one presented here could be invalid because

1. Some risk/hazard systems were applied in areas other than where they were developed.
2. Some systems were adjusted to show measurement of hazard in the high, medium, and low format. This was an intuitive adjustment and may or may not accurately represent the system.

Table 3. Treatment combinations with the same mean and standard deviation.

| | | Treatment Nos. [2] |
|---|---|---|
| Row[1] | a. | 5, 6, 7 |
| | b. | 4 |
| | c. | 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 |
| | d. | 1, 2, 3 |

[1] Each row is different from all other rows at the 5 percent level of significance.

[2] Explanation of treatments. All treatments within a row are not different at the 5 percent level of significance.

Ku's System (5, 6, 7), row a, (4) row b

Lorio's rating - a recombination of the 5 factor risk rating where 1 = very high, 2 = high, 3 = moderate, 4 = low, and 5 = none. The combination resulted in 1 + 2 = 1 (high), 3 + 4 = 2 (med), and 5 (low) = 3 (8) row c

Smith (9 - 20) row c

1) Mason, 2) Porterfield, 3) Kushmal (1, 2, 3) row d

For a list of rating variability, see p. 3.

The conclusions of the analysis does show that several risk/hazard systems measure SPB hazard the same. Also, that there are differences between groups of systems at the 5 percent level of significance.

Basal area

Basal area measurements from the prescriptionists tally sheets (total BA) and actual cruised data (total BA) were not statistically different at the 5 percent level. Also prescription average basal area (total pine and hardwood), prescription average basal area (pine), cruise data (average basal area pine), and photo basal area using regression formulas number 1, 4, and 5 were not statistically different at the 5 percent level of probability.

None of the measurements of pine basal area were statistically different. This infers that any of these methods could be used with a confidence level of 95 percent. Since data from the 10 cruised stands supported the hypothesis that no differences existed between cruised data, prescriptionist's data, and photo data, prescriptionists and photo basal areas were then evaluated on 42 stands to further ascertain if differences existed. There were no statistical differences found in the pine measurements at the 5 percent level of probability.

## DISCUSSION

Results of the basal area and hazard rating studies indicate that systems requiring basal area could use photos to obtain this information. This basal area is accurate to the 95 percent confidence level. Any of these basal area methods could be used to gather data for a SPB hazard rating system. Since several hazard rating systems do measure alike, it is possible for State and industrial foresters to have a choice in selecting a SPB hazard rating system.

Implementation of these hazard rating systems will be less troublesome if data needs for the hazard rating systems coincide with the user's timber inventory data.

Basal area can be obtained in a short time from photos. Average time spent during the study was less than one-half hour per stand. Risk/hazard systems can be used by the prescriptionist to rate stands without impacting a forester's time. Also, risk/hazard rating systems which produced like results could be used where any of the like group's systems have been validated. For example, Mason, Porterfield, and Kushmals models should work equally well in any of the areas where they were developed.

New hazard rating systems and updated versions of the systems used in this evaluation will be forthcoming within the next year. It is the

author's hope that the raw data can be used once again to compare systems and group them according to results. Ultimately, this grouping of like systems will give the land manager a choice of the rating system which best fits his needs and data base.

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